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The Dynamic Econometric Model in the Studying of Employment Changes in a Small Enterprise

1. Introduction

Small enterprises are the fundament of all market economies. Only few of them have the possibilities of using specialized decision tools, such as econometric and statistic instruments. It is because they demand from the owner, or from the hired specialist the knowledge acquired as a rule on the first stage of economic studies.

The relative easiness of creating and developing small enterprises – within definite limits – gives the chance of fast economic development and at the same time the reduction of unemployment. This is why the enterprises from the group of this sector are the biggest chance for all market economies and for the Polish economy as well. The development of small enterprises should be treated as the strategic goal of all undertaken policies – influencing the future. There is a necessity of complete elimination of barriers, because they limit not only the creating, but also the functioning of this group of enterprises. It is very important then to eliminate all reasons which cause decreasing demand for labour force in small enterprises.

2. Small Enterprises in Creating Work Places in Poland

It is worth then to analyze changes in the functioning of small enterprises in Poland after 1990. The first half of the ninetees was a period of great optimism and fast growth of the sector of small enterprises in our country. The breakdown took place in 1994. The illustration of this decline is given by Fig. 1, which shows the number of employers and self-employed in the years 1990–2001. In

the following years, after 1995, the spurious increase in the number of small enterprises in Poland has been observed. The changes, which have been introduced to the Work Code, being in force from the 1st of January 1995, have caused a replacement of many employment contracts[1] with the so called civil-law agreements. As a result in the public statistics the increase in the number of employers and self-employed appeared, what should be considered from the point of the total employment in the economy in the analysed period.

After 1998, the 'true picture' of this process had been revealed. Since this time, the number of entities has been decreasing systematically, but the small enterpises had the main portion in this decrease. Equation (1) illustrates the autoregressive-trend mechanism for the investigated variable. The positive trend can be considered as a short-term characteristic. It is expected that in close future this direction will be reversed, if the conditions of the functioning of the economy in Poland do not change.

Fig. 1. The employers and self-employed in Poland in years 1990–2001 (in thousands of people)
Source: Author's calculations on the basis of GUS Statistical Yearbooks.

[1] The employment contract approved for the third time had to be extended as the unlimited time contract. Many employers have forced their workers to register a business activity. As the result of such a change, there have been approved agreements for rendering services by a one-man business. These services have been rendered by previous workers.

The empirical equation describing the process of variability in the number of the employers and self-employed has the following form[2]:

$$PR = \underset{(7.845)}{8887} - \underset{(3.366)}{0.777}\, PR_{-3} + \underset{(4.404)}{84.9}\, t + u_1, \qquad (1)$$

$R_1^2 = 0.767$, $S_{1u} = 111.5$, $DW_1 = 2.392$.

Actual and theoretical values of the PR variable and the residuals of equation (1) illustrates Fig. 2. The residuals in equation (1) are denoted by u_1. A small number of statistical observations (n = 12) makes it difficult to analyze this variable more deeply, by using econometric tools. The accuracy of describing of analyzed processes can be treated as insignificant.

Fig. 2. Actual and fitted the PR variable with residuals calculated[3] on the basis of equation (1)
Source: Author's calculations.

In the longer period, the change of the rule of variability of the variable PR can be expected. The main reason for it would be the corrections of government policies influencing the conditions of the functioning of the system. The conse-

[2] Below the estimates of structural parameters the empirical values of the t-Student statistic are given. Moreover, the values of determination coefficient (R_1^2), standard error of residuals (S_{1u}), and Durbin-Watson statistic (DW_1) are included to the equation.

[3] *Actual* line means actual PR values, *Fitted* – theoretical values calculated on the basis of empirical equation (1), *Residual* – residuals in the equation.

quence of these changes would be the necessity of another specification and analysis of the equation describing the number of the employers and self-employed.

3. The Mechanism of Employment in a Small Enterprise

Empirical research was carried out in a small production enterprise, functioning in the publishing-printing sector. The enterprise has been operating from 1991. From the year 1995, it has been operating in its own buildings[4], which has lead to its stabilization. From January 1996, the gathering of statistic data has begun, independent of the data gathered for financial and tax purposes.

The changes of conditions of the running the business activity in Poland after 1995 have encouraged small enterprises to undertake actions tending to substitute the labor force with machinery and equipment. These processes will be illustrated by the study results, carried out in the described small enterprise. This purpose will be achieved by the use of empirical equations describing the relationships between employment and fixed assets[5] in the enterprise.

The equation describing the mechanism of employment on the basis of quarterly time series has the following form:

$$ZATR = \underset{}{7.668} + \underset{(1.898)}{0.801}\ ZATR_{-1} - \underset{(3.068)}{0.604}\ ZATR_{-2} + \underset{(2.715)}{0.359}\ ZATR_{-3} + \underset{(4.195)}{}$$

$$+\underset{(2.423)}{0.0441}\ MASZ_{-4} - \underset{(3.068)}{0.651}\ t + u_2, \qquad (2)$$

$R_2^2 = 0.734$, $S_{2u} = 1.4$ persons, $DW_2 = 2.257$.

The autoregressive dependencies of third order are the dominating characteristic of the employment in the enterprise. A mechanism of employment correction has been observed, which is reflected by a negative estimate of the structural parameter by the $ZATR_{-2}$ variable. It means that every half a year the correction of employment is made, which consists in reducing the number of employees by one person a year on average.

[4] The enterprise had changed its buildings many times. The lease of the buildings was always connected with high costs of rents paid for the lease. These charges had been raised systematically.

[5] The research was carried out in two ways: using monthly data and quarterly time series from 1996 till 2002.

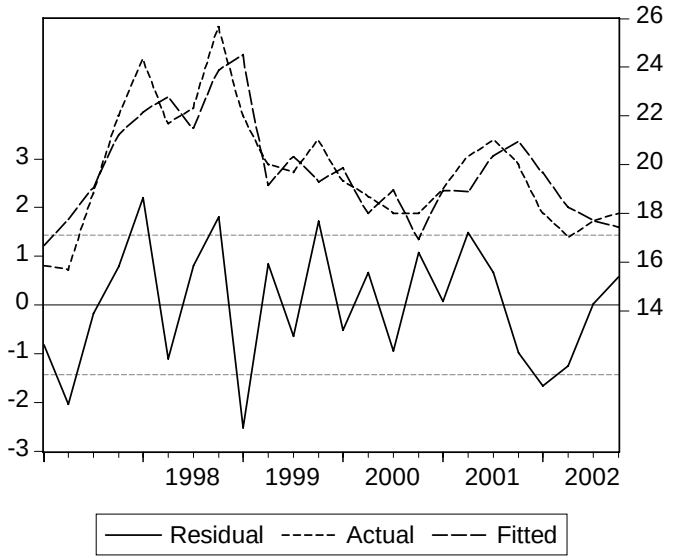

Fig. 3. Actual and fitted quarterly employment with residuals calculated on the basis of equation (2)
Source: Author's calculations.

The enlargement of a machinery park causes an increase in employment, i.e. the fourth lag of the initial value of machinery and equipment is statistically significant. The increase of the machinery park value by about 23 thousand PLN results in the increase of employment in the enterprise by one person.

Quarterly employment contains a negative linear trend. It means that in each quarter the reduction of employment is observed, which in total leads to the reduction by 1 person every half a year on average. This trend has been intensified at the end of the nineties, and existed until the end of the observation period. It was the reaction on the low flexibility to employ people in Poland and also on continuously increasing labor costs as the effect of the policies of successive governments.

The goodness of fit of the quarterly employment mechanism is moderate, because the explanatory variables included in equation (2) explain the 73.4% of total fluctuations of the ZATR variable. However, the first order autocorrelation of residual process does not occur in equation (2), because $DW_2^* = 1.743 > d_2 = 1.53$, at the 1% significance level. Fig. 3 illustrates a quarterly variability of employment and the results obtained on the basis of the empirical equation (2).

The empirical equation describing the monthly employment mechanism has the following form[6]:

$$ZATR = \underset{(3.092)}{4.443} + \underset{(7.872)}{0.860}\, ZATR_{-1} - \underset{(2.106)}{0.303}\, ZATR_{-2} + \underset{(3.341)}{0.368}\, ZATR_{-3} -$$

$$- \underset{(3.133)}{0.292}\, ZATR_{-5} + \underset{(1.845)}{0.134}\, ZATR_{-8} + \underset{(2.493)}{0.0164}\, MASZ_{-12} - \underset{(2.841)}{0.0871}\, t + u_3, \qquad (3)$$

$R_3^2 = 0.803$, $S_{3u} = 1.2$ persons, $DW_3 = 1.941$.

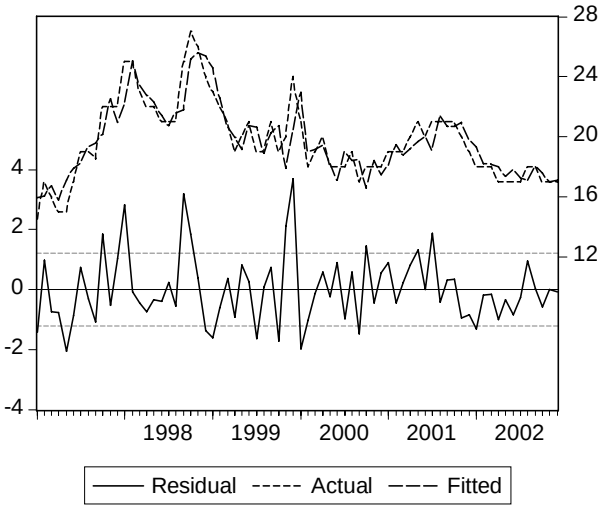

Fig. 4. Actual and fitted monthly employment with residuals calculated on the basis of equation (3)
Source: Author's calculations.

The employment equation estimated for monthly data shows strong autoregressive dependencies of variable ZATR. The employment contracts, especially signed for unlimited time cause that the current employment is influenced by the lagged employment, i.e. from earlier months. Not all autoregressive dependencies are significant in the same extent. The variable $ZATR_{-8}$ can be recognized as statistically significant at the 6.96% significance level, but $ZATR_{-2}$ – at the 3.91% significance level. These errors of type I are not too high when the microeconomic equation estimated on monthly time series is taken into account.

It turns out that the twelfth lag of the initial value of machinery and equipment plays the role of the employment accelerator. The increase of employment

[6] The 1% upper critical value amounts to $d_u = 1.62$. There is an inequality $DW_3 = 1.941 > d_u > 1.62$. It means that the null hypothesis of the non-correlation of residual process cannot be rejected.

by 1 person in the current month is the consequence of the enlargement of the machinery park 12 months earlier about 61 thousand PLN according to the net purchase value. In the small enterprise the complementary relationships between employment and the value of machinery and equipment are observed.

This study has shown, that the initial value of fixed assets[7] MTRW was not statistically significant as in the employment equation for quarterly data, as well for monthly data. In practice, only changes of the MASZ variable, i.e. value of machinery and equipment (with appropriate lags) generate the necessary correction of employment in the group of workers. The means of transportation are connected with sale representative working in the chain sale. In the analyzed period the number of sale representatives and chain sales was stable. As the result only the changes of production machinery produced the appropriate reaction of the ZATR variable. The negative trends in employment as for quarterly data, as well for annual data result from the substitution of labour force with the fixed assets, which was observed with high intensification in last period.

4. The Equation of Fixed Assets in a Small Enterprise

The quarterly mechanism, describing the initial value of fixed assets has the following empirical form:

$$\underset{}{MTRW} = \underset{(2.128)}{24.853} + \underset{(32.413)}{0.919}\, MTRW_{-1} + \underset{(2.374)}{0.0654}\, PIEN_{-4} + u_4, \qquad (4)$$

$R_4^2 = 0.984$, $S_{4u} = 13.716$ thousand PLN, $DW_4 = 2.590$.

Fixed assets in the enterprise described quarterly, are highly influenced by first lag of fixed assets. Moreover, the forth lag of money inflows has the positive impact on current values of fixed assets. It results from the fixed assets investment policy applied in the enterprise which consists in investing only self funds. In practice it means that only significant cash inflows taking place 4 quarters earlier enable the increase of fixed assets. The cash inflow of 100 thousand PLN, 4 quarter earlier, has been increasing the current value of MTRW variable by 6540 PLN on average.

Banking credits are too expensive for a small enterprise, and the procedures of obtaining the outside sources of financing the business activity and its development are too complicated. Additionally exaggerated securities are imposed on these procedures. All these difficulties disincline the owner of small business to apply for the credit. As a result the possibilities of the development of small in enterprise are strongly limited.

[7] MTRW variable includes the value of machinery and equipment, the value of buildings, and means of transport.

Equation (4) with high goodness of fit describes the variability of the fixed assets value, because the first lag of fixed assets and fourth lag of money inflow explains 98.4% of the total variability of MTRW. The fitted values of fixed assets differ from their actual values by 13.716 thousand PLN on average, which constitutes 3.69% of the average value of MTRW in the period from 1996 to 2004. The first order autocorrelation of residual process does not occur, because $DW_{15}^* = 1.410 > d_u = 1.20$ assuming the significance level γ of 1%. However, the initial value of machinery and equipment (MASZ) with appropriate lags (calculated quarterly or monthly) should be treated as the variable having the important impact on the employment in the analyzed enterprise. Therefore the importance should be attached to the equations describing the MASZ variable.

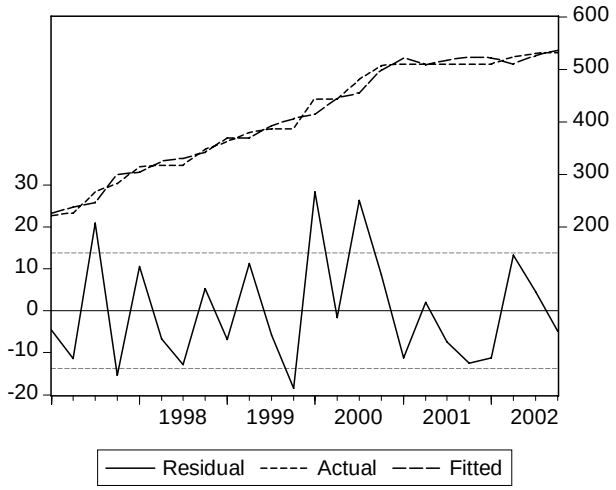

Fig. 5. Actual and fitted initial values of fixed assets (quarterly data) with residuals calculated on the basis of equation (4)
Source: Author's calculations.

The empirical equation describing the MTRW variable on monthly time series has the following form:

$$\underset{}{MTRW} = \underset{(1.575)}{17.911} + \underset{(10.042)}{0.755}\ MTRW_{-1} + \underset{(3.819)}{0.422}\ MTRW_{-7} - \underset{(2.602)}{0.292}\ MTRW_{-8} -$$
$$-\underset{(1.421)}{0.0640}\ PIEN_{-2} + \underset{(2.633)}{0.1156}\ PIEN_{-4} - \underset{(2.013)}{0.1004}\ PIEN_{-7} + \underset{(1.682)}{0.803}\ PIEN_{-8} +$$
$$\underset{(1.710)}{0.0796}\ PIEN_{-12} - \underset{(1.935)}{2.133}\ PLAC_{-6} + \underset{(1.841)}{2.226}\ PLAC_{-7} + \underset{(1.845)}{1.549}\ PLAC_{-12} + u_5, \quad (5)$$

$R_5^2 = 0.991$, $S_{5u} = 10.472$ thousand PLN, $DW_5 = 1.835$.

Monthly fluctuations of the initial fixed assets value are caused by numerous explanatory variables. The first, seventh and eighth lag of the MTRW variable plays an important role. Besides, lagged money inflows (PIEN) received from the customers has the significant impact on fixed assets. However, the impact of $PIEN_{-2}$ variable (p-value = 0.16), $PIEN_{-8}$ variable (p-value = 0.0977), and $PIEN_{-12}$ variable (p-value = 0.0925) is relatively weak. The influence of variable PIEN with different lags confirms earlier hypothesises, and previously received results.

Additionally the influence of net wages fund (PLAC) lagged with 6, 7, and 12 months on the fixed assets has been observed. The joint positive effect of the $PLAC_{-7}$ and $PLAC_{-12}$ variables exceeds the negative effect of the $PLAC_{-6}$ variable. It means that with the increase of the net wages fund, the increase of initial value of fixed assets takes place. This increase of fixed assets can be interpreted as the reaction on growing labor costs.

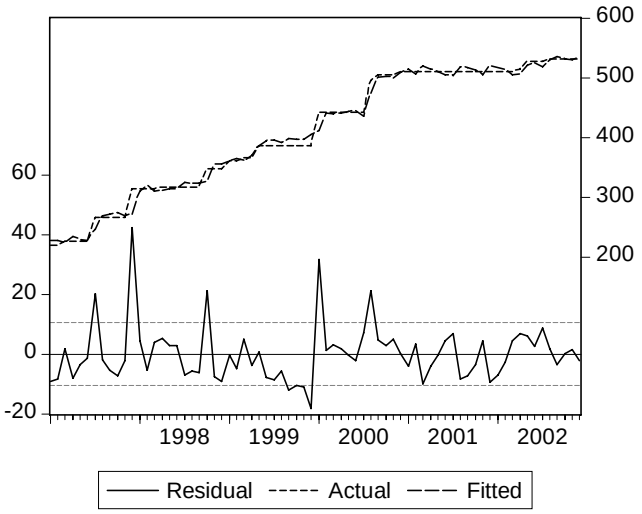

Fig. 6. Actual and fitted initial values of fixed assets (monthly data) with residuals calculate on the basis of equation (5)
Source: Author's calculations.

Equation (5) with high goodness of fit describes the fluctuations of MTRW variable (see Fig. 6), i.e. The explanatory variables explain about 99.1% of the total variability of MTRW. Fitted values of fixed assets differ from their empirical values by 10472 PLN on average, which constitutes 2.8% of the average monthly value of MTRW in 1996–2002.

The next equation explains the variability mechanism of the initial values of machinery and equipment (MASZ) on the basis of quarterly data. It has the following form:

$$\underset{}{MASZ} = \underset{(4.128)}{45.886} + \underset{(23.79)}{0.884}\ MASZ_{-1} + u_6, \qquad (6)$$

$R_6^2 = 0.958$, $S_{6u} = 18.979$ thousand PLN, DW_6[8] $= 1.642$.

The value of machinery and equipment is influenced only by its first lag. This autoregression model of first order explains till 95.6% of total quarterly variability of MASZ. No influence of a lagged PIEN variable has occured.

The empirical equation explaining the variability mechanism of the initial values of machinery and equipment on the basis of monthly data has the following form:

$$\underset{}{MASZ} = \underset{(0.564)}{4.419} + \underset{(13.394)}{0.756}\ MASZ_{-1} + \underset{(4.960)}{0.463}\ MASZ_{-7} - \underset{(3.531)}{0.320}\ MASZ_{-8} +$$

$$\underset{(3.235)}{0.0995}\ PIEN_{-4} + \underset{(3.117)}{0.0973}\ PIEN_{-8} + \underset{(3.052)}{0.1061}\ PIEN_{-12} - \underset{(3.267)}{1.607}\ PLAC_{-1} +$$

$$+ \underset{(3.212)}{1.667}\ PLAC_{-12} + u_7, \qquad (7)$$

$R_7^2 = 0.991$, $S_{7u} = 8.091$ thousand PLN, $DW_7 = 2.129$.

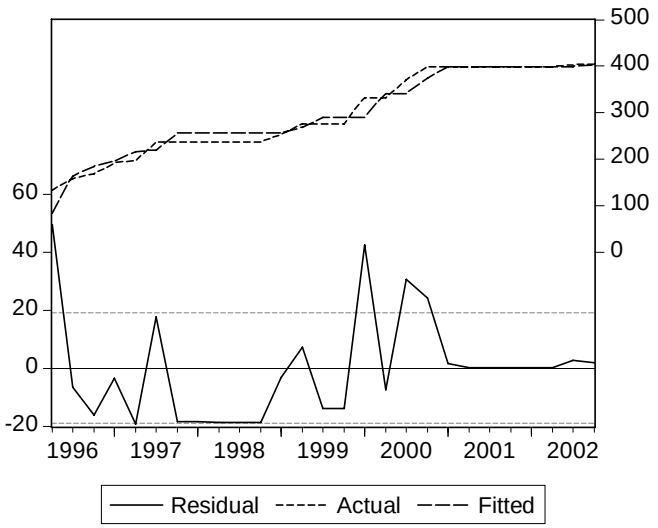

Fig. 7. Actual and fitted initial values of machinery and equipment (monthly data) with residuals calculated on the basis of equation (6)
Source: Author's calculations.

[8] Upper critical value $d_u = 1.23$ for $\gamma = 0.01$.

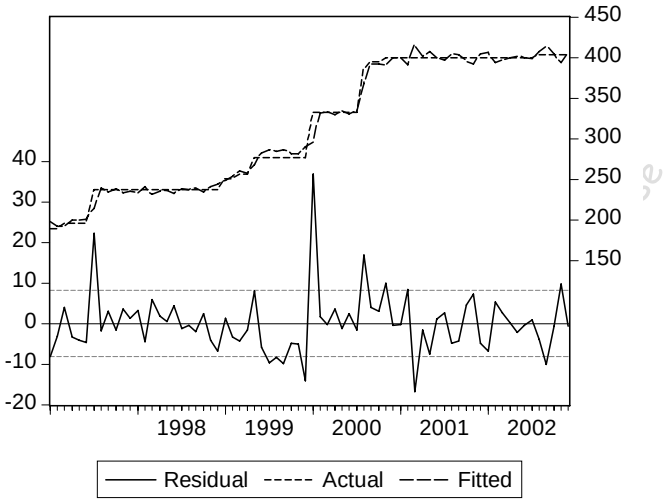

Fig. 8. Actual and fitted initial values of machinery and equipment (monthly data) with residuals calculated on the basis of equation (7)
Source: Author's calculations.

In equation (7) visible analogies to the mechanism of the total variability of fixed assets can be seen, because the MASZ variable is the dominating component of the MTRW variable, i.e. it constitutes on average about 77% of MTRW. All remarks and explanations attached to equation (5) may be used in the case in question.

5. The Equation of Investment Outlays in a Small Enterprise

The next four empirical equations on the basis of quarterly and monthly data describe the mechanism of investment, which aims to the increase of the total value of fixed assets and the value of machinery and equipment separately as well. These are as follows:

– the empirical equation of investment outlays increasing the total value of fixed assets quarterly:

$$\underset{}{INW} = \underset{(2.752)}{32.922} - \underset{(1.685)}{0.303}\, INW_{-1} - \underset{(2.080)}{0.272}\, INW_{-4} + \underset{(2.455)}{0.0628}\, PIEN_{-4} - \underset{(3.630)}{1.799}\, t + u_8, \quad (8)$$

$R_8^2 = 0.480$, $S_{8u} = 12.918$ thousand PLN, $DW_8 = 1.800$;

– the empirical equation of investment outlays increasing the total value of machinery and equipment quarterly:

$$\underset{(2.006)}{\text{INWMASZ} = -59.71} - \underset{(1.412)}{0.293\,\text{INWMASZ}_{-1}} + \underset{(1.879)}{0.07547\,\text{PIEN}_{-1}} + \underset{(2.106)}{0.0824\,\text{PIEN}_{-2}} +$$

$$+ \underset{(2.658)}{0.0602\,\text{PIEN}_{-3}} + \underset{(2.942)}{0.1027\,\text{PIEN}_{-4}} - \underset{(1.543)}{2.126\,t} + u_9, \qquad (9)$$

$R_9^2 = 0.381$, $S_{9u} = 14.929$ thousand PLN, $DW_9 = 1.835$;

– the empirical equation of investment outlays increasing the total value of fixed assets monthly:

$$\underset{(1.305)}{\text{INW} = -13.197} - \underset{(1.666)}{0.188\,\text{INW}_{-1}} - \underset{(1.982)}{0.224\,\text{INW}_{-2}} + \underset{(2.889)}{0.313\,\text{INW}_{-7}} + \underset{(1.766)}{0.0873\,\text{PIEN}_{-4}} +$$

$$+ \underset{(2.130)}{0.0979\,\text{PIEN}_{-8}} + \underset{(1.938)}{0.0847\,\text{PIEN}_{-10}} + \underset{(2.398)}{0.1057\,\text{PIEN}_{-12}} + \underset{(2.511)}{3.108\,\text{AMORT}} +$$

$$-\underset{(3.207)}{4.008\,\text{AMORT}_{-3}} - \underset{(1.995)}{0.467\,\text{ASOR}} + u_{10}, \qquad (10)$$

$R_{10}^2 = 0.298$, $S_{10u} = 10.93$ thousand PLN, $DW_{10} = 2.013$;

– the empirical equation of investment outlays increasing the total value of machinery and equipment monthly:

$$\underset{(3.565)}{\text{INWMASZ} = -26.083} + \underset{(4.476)}{0.412\,\text{INWMASZ}_{-7}} - \underset{(1.473)}{0.118\,\text{INWMASZ}_{-9}} +$$

$$+ \underset{(3.559)}{0.138\,\text{PIEN}_{-4}} + \underset{(2.839)}{0.095\,\text{PIEN}_{-8}} + \underset{(2.535)}{0.078\,\text{PIEN}_{-10}} + \underset{(1.872)}{0.063\,\text{PIEN}_{-12}} +$$

$$\underset{(3.188)}{5.221\,\text{AMORT}} - \underset{(3.650)}{5.971\,\text{AMORT}_{-1}} - \underset{(2.343)}{0.154\,t} + u_{11}, \qquad (11)$$

$R_{11}^2 = 0.447$, $S_{11u} = 8.316$ thousand PLN, $DW_{11} = 2.099$.

The Fig. 9–12 below illustrate the results achieved in equations (8)–(11).

All the equations (8)–(11) explain the rules of investment outlays with low goodness of fit. The common feature of investment outlays as a whole or investment outlays only in machinery and equipment is a decreasing trend, signaling that the strategy of dynamic development has been replaced with the strategy of keeping still in existence. The investment outlays undertaken after the year 2000 were "compulsory" in nature. Then the necessary exchange of the means of transport took place, because the costs of exploitation and the risk of breakdown were too high. Without this exchange the regularity of chain-sale service would be broken.

Fig. 9. Actual and fitted investment outlays (quarterly data) with residuals calculated on the basis of equation (8)
Source: Author's calculations.

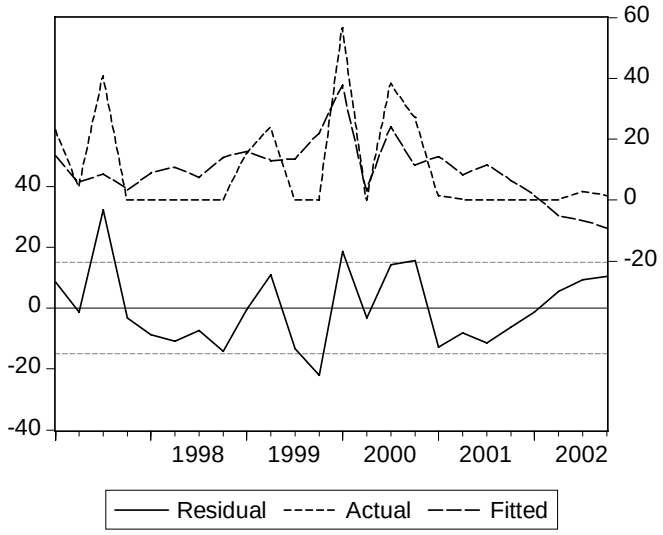

Fig. 10. Actual and fitted investment outlays in machinery (quarterly data)with residuals calculated on the basis of equation (9)
Source: Autors's calculations.

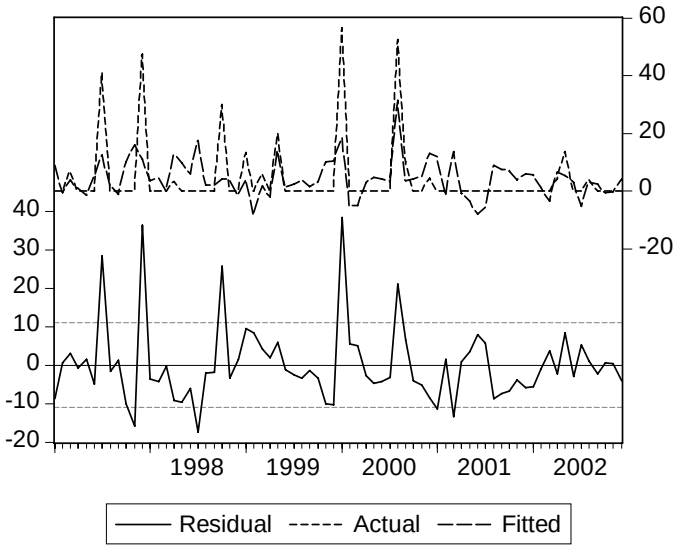

Fig. 11. Actual and fitted investment outlays (monthly data) with residuals calculated on the basis of equation (10)
Source: Author's calculations.

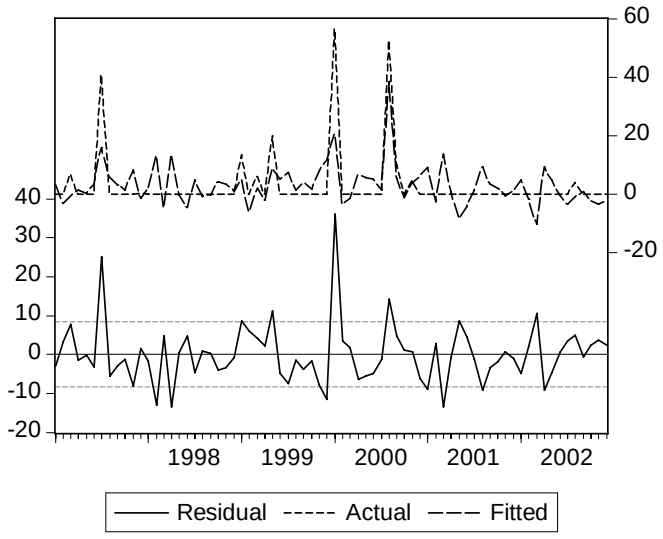

Fig. 12. Actual and fitted investment outlays in machinery (monthly data) with residuals calculated on the basis of equation (11)
Source: Author's calculations.

6. Summary

We are still waiting for "better times" for small entrepreneurs. The negative aftermaths are summed up in the scale of the whole economy and the state. The radical change of functioning conditions of the enterprises, consistent with proposition included on the page in the web site http://www.misie.pl/prop_sys.htm, can emancipate the great energy in small enterprises inclining them to a bigger investment. Growing investment is one of the most important conditions of improving prosperity in the scale of the whole economy.

Looking from the social point of view, it is not advantageous to substitute labor force with machinery and equipment too fast. There is a rapid need to introduce instruments of policies, which would encourage enterprises to employ people. The biggest possibilities in this area are given small enterprises, which could absorb labor surpluses in a short period. In order to reach that the radical reforms in tax law, the Labour Code law, also the elimination of numerous barriers of economic liberty system are needed.

The analysis of single variables and undertaking decisions on the basis of isolated elements of the system could be a huge mistake, often made in the enterprises. The decisions should take into account the complexity of investigated phenomenon. Therefore they should be based on econometric models composed of many equations. The standard system should be the chain: investment → → fixed assets → employment. These relationships do not have to be simultaneous. The possible existing lags in this chain should be specified on the basis of previously carried out empirical and numerical experiments.

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